

## Aluminium Industry: The Silver Knight of the Economy

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### Overview

*Aluminium is one of the lightest metals in the world and as a result it is used widely in the production of multiple products. This metal has a shiny silver colour and it is malleable meaning it can be bend without breaking. In nature, aluminium is found in an ore called bauxite. Bauxite is the basic raw material in the aluminium manufacturing process. Bauxite is converted into alumina in alumina refineries.*

*Aluminium is the 3<sup>rd</sup> most available element present in the earth's crust and the 2<sup>nd</sup> most used metal after steel. According to USGS India ranks 9<sup>th</sup> in terms of bauxite reserves in the world.*

*The Aluminium production process can be divided into upstream and downstream activities. The upstream process involves mining and refining activities, while downstream process involves smelting and casting & fabricating. Aluminium downstream fabricated products include rods, sheets, extrusions and foils.*

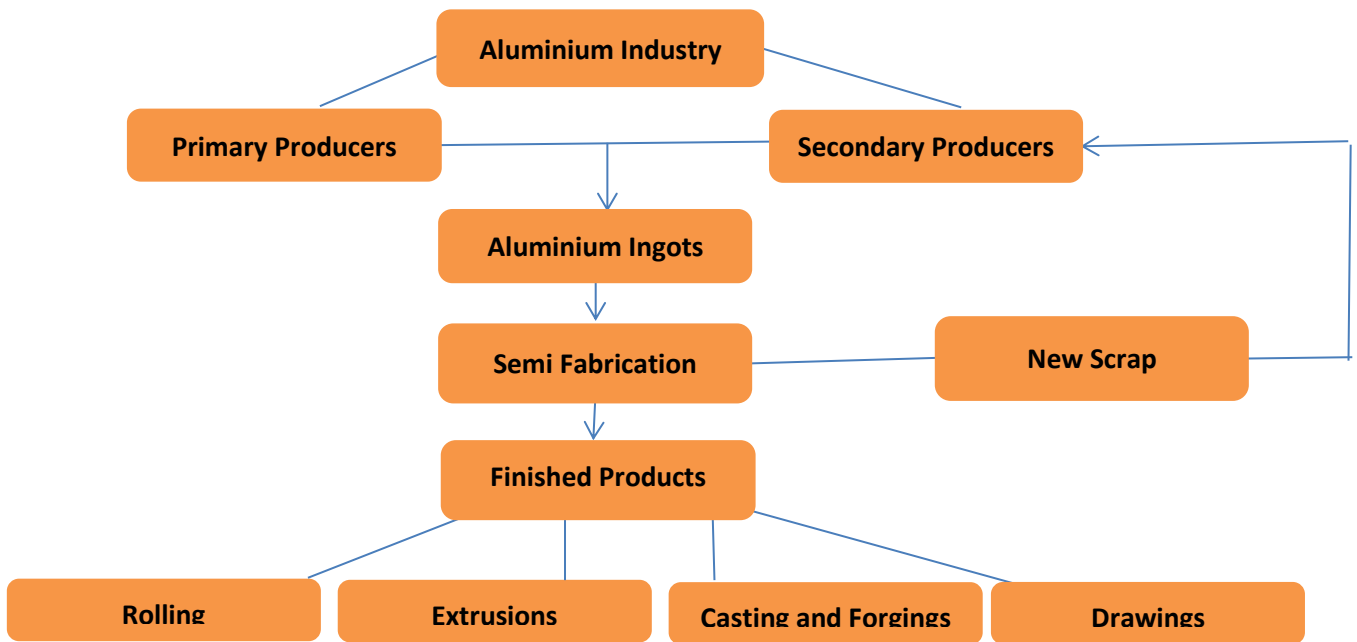
*Globally, aluminium is produced by two different methods, the primary production process which involves the conversion of ores to aluminium and the other is secondary production (recycling) where the aluminium scrap is recycled to produce aluminium again. In India primary aluminium industry is dominated by 3 companies: Hindalco and Vedanta which are privately owned and NALCO which is a public sector undertaking having a Navratna status.*

### Process of manufacturing Aluminium

Aluminium production first begins with the mining of bauxite and ends with liquid aluminium getting converted into various products. The aluminium production process can be broken down into three stages; first bauxites, which contain aluminium, are extracted from the ground. Second, bauxites are processed into alumina or aluminium oxide, and finally pure aluminium is produced.

The aluminium process begins with the mining of bauxite. Bauxite consists of 45-60% aluminium oxide, along with various impurities such as sand, iron, and other metals. Approximately it takes 3-4kgs of bauxite to produce 1kgs of alumina and it takes 2kgs of alumina to produce 1kg of aluminium. The process of Bauxite refining involves the use of Bayer Process and once the bauxite is converted to alumina, further on the process of reduction of alumina to aluminium is called Hall- Heroult process.

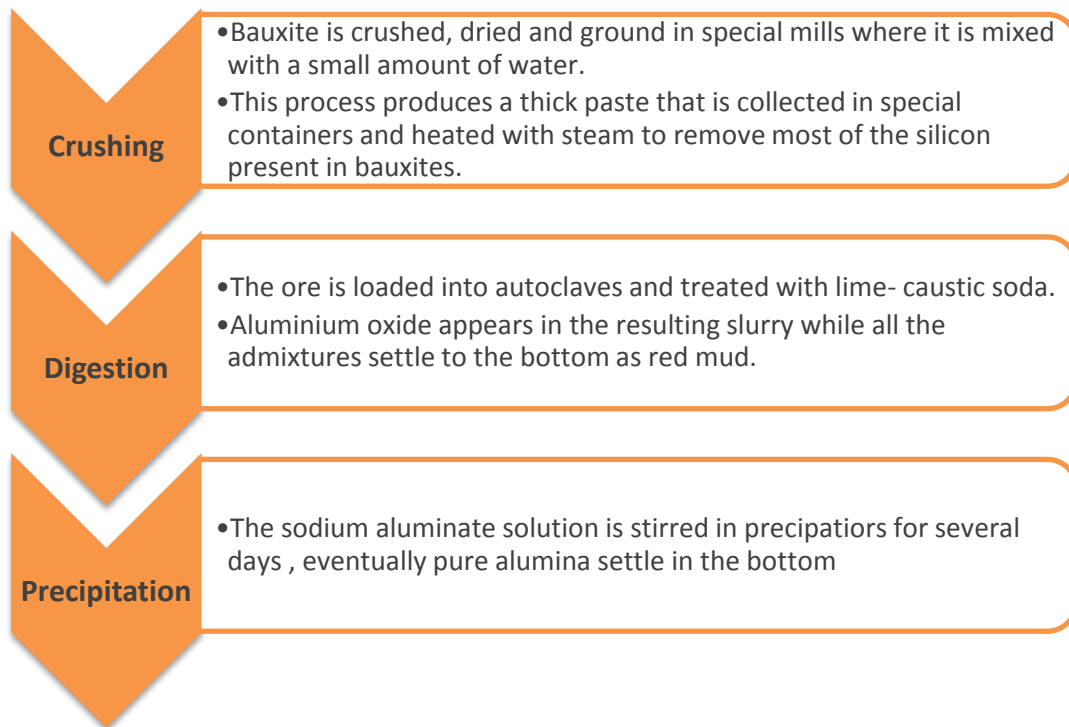
Chart 1: Structure of the Aluminium Industry



Source: CARE Research

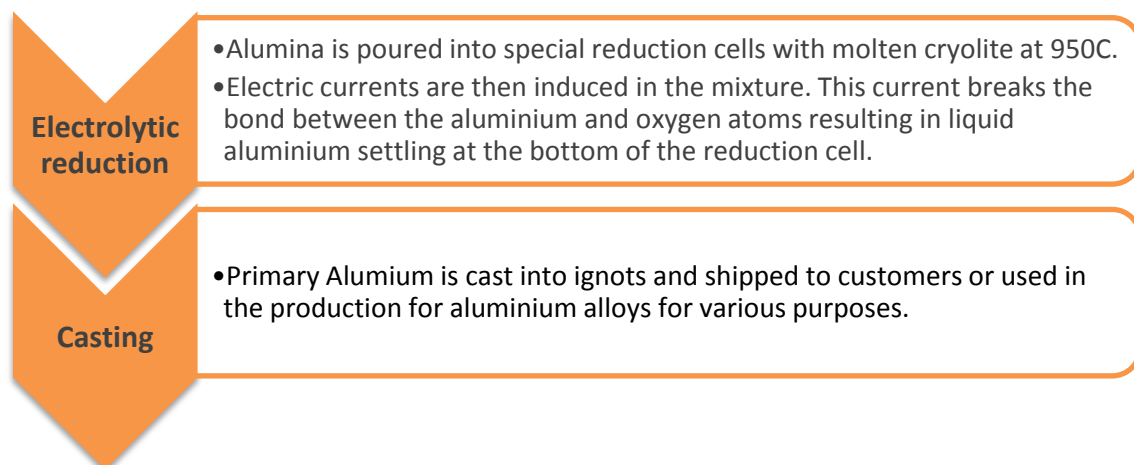
Bauxite, Alumina and Power constitute the major components of the total operating costs. Other raw materials used in the manufacturing process included are calcined petroleum coke, caustic soda, aluminium fluoride, fuel/oil and steam/anthracite coal. The average electricity consumption for the production of 1 tonne of aluminium is about 15,000 kwh, whereas for alumina the same is about 260 kwh per tonne. Since it takes 2 tonnes of alumina to manufacture 1 tonne of aluminium, of the 15,000 kwh, about 500kwh is consumed during the process of refining the bauxite to alumina, while the rest is consumed in the electrolysis process.

**Chart 2: Steps to Manufacture Alumina: Bayer Process**



Refined Alumina is then passed through the smelters to get transformed to Aluminium. Manufacturers of aluminium are located near cheap and abundant sources of power as power is one of the largest cost components in manufacturing, as production of aluminium requires electrolysis. In India, the aluminium manufacturing companies have their own captive power plants which make the cost of production cheaper vis-a-vis to using commercial power.

**Chart 3: Steps to Manufacture Aluminium: Hall- Heroult Process.**

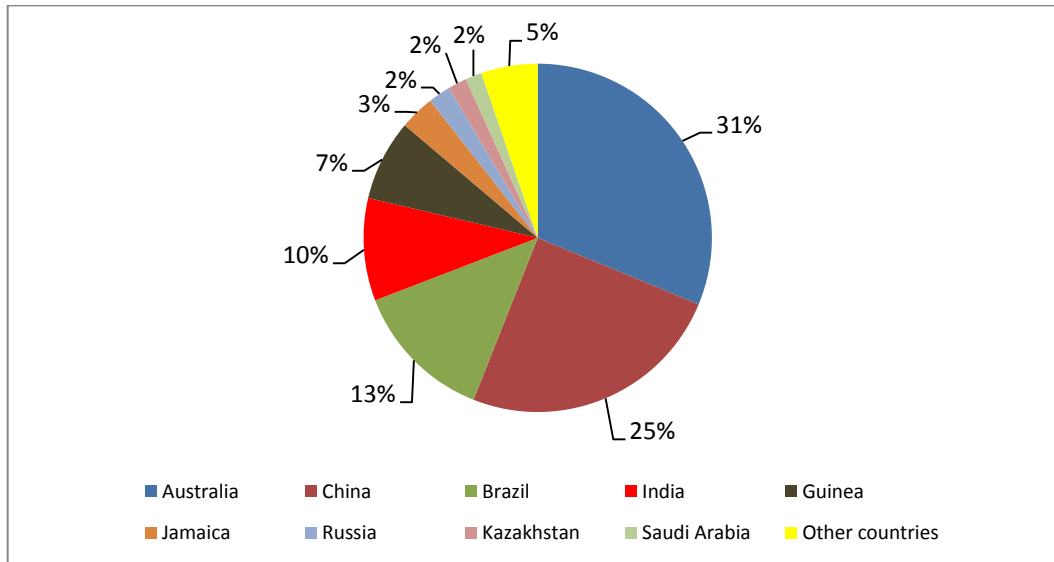


**Secondary production** of aluminium involves recycling of the aluminium. Aluminium does not lose any of its properties when it gets recycled. The added benefit when aluminium gets recycled is that it consumes only 5% of the energy needed to make the same amount of primary aluminium. In addition, recycling aluminium significantly reduces the negative environmental impact of ever-expanding landfills.

**Bauxite**

Bauxite contains alumina in three different forms: Gibbsite, Boehmit and Monohydrate. All three types of bauxite are soluble in caustic soda but the treatment of boehmite and monohydrate is more expensive vis-à-vis than the treatment of gibbsite.

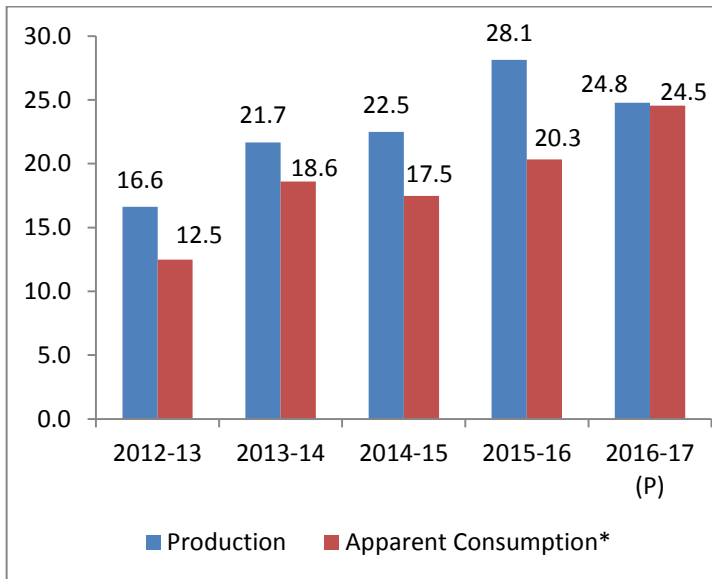
**Chart 4: World Bauxite Mine Production for CY 2016**



Source: United States Geological Survey (USGS) minerals commodity handbook, 2017

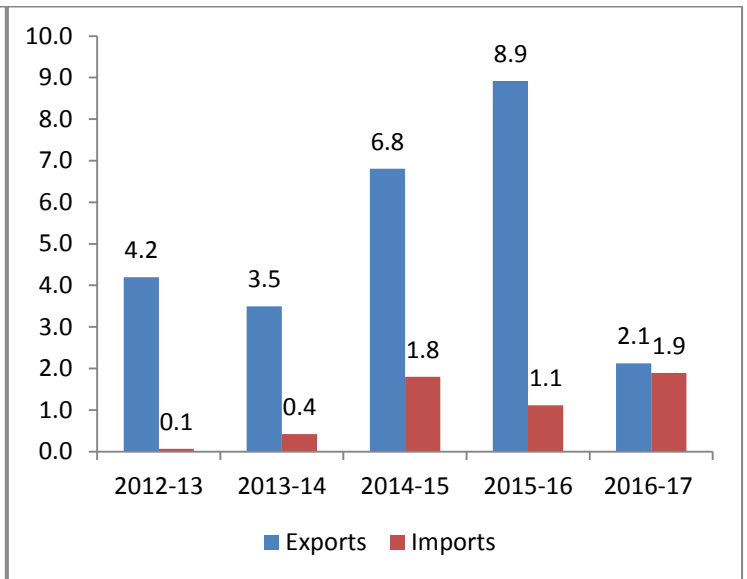
India has 593 million tonnes of bauxite reserves and is naturally endowed with large deposits of gibbsitic bauxite. According to Indian Bureau of Mines there are reported 152 mines of which 134 operate in the private sector and 18 mines fall under the public sector. Odisha ranks 1<sup>st</sup> in mine production followed by Gujarat, Jharkhand and Maharashtra. The abundant reserves of bauxite have made India a net exporter of bauxite. Bauxite is primarily used for the production of alumina, other than that it is also used in refractories, abrasives, chemicals, aluminous cements, and miscellaneous products like proppants.

**Chart 5: Production Consumption of Bauxite (mn tonnes)**



Source: Indian Bureau of Mines

**Chart 6: Import- Export trends of Aluminium ore (mn tonnes)**



Source: Indian Bureau of Mines, DGFT

\*Apparent Consumption= Production + Imports -Exports

Production of bauxite is growing at a healthy rate of 10.5% CAGR from FY 2012-13 to FY 2016-17. As India has bountiful bauxite reserves and mining potential, there is a constant rise in the production and mining of bauxite. On the other hand apparent consumption is growing at a CAGR of 18.4% from FY 2012-13 to FY 2016-17. Till FY 2015-16 India was consuming around 75%-80% of the bauxites produced while the rest of the commodity was being exported. Now due to the rise in the demand of aluminium in the domestic markets there has been a sudden drop in the exports in FY 2016-17.

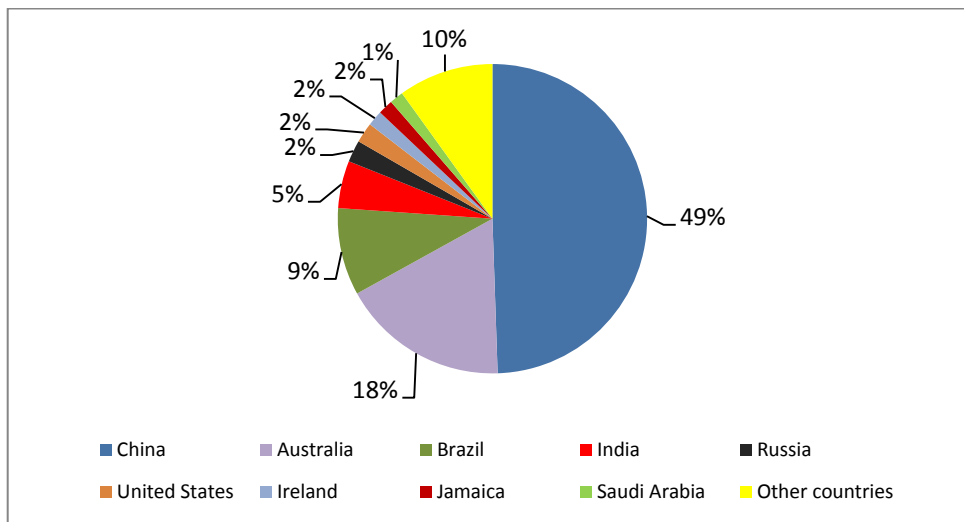
India exports bauxites to China, Nepal, Saudi Arabia, France, Japan, Slovenia, USA, UK, Oman, Italy and Kuwait. China is the main importer of bauxites from India, almost to an extend of 90% of the total bauxite exports. Imports are quiet negligible in comparison to the exports but whatever little India imports its' from Guinea and Brazil.

**Alumina**

Once the bauxite passes through the Bayer process of manufacturing, the finished product is alumina. Alumina is processed in the refinery plants. Metallurgical alumina is used for the manufacturing of aluminium. Chemical alumina and hydrates are used in range of industries including water treatment, fillers in cables and plastics, refractories and ceramics, glass among others.

Smelter-grade alumina accounts for 90% of all alumina produced; it is transported to aluminium plants, where it is electrolyzed into aluminium metal.

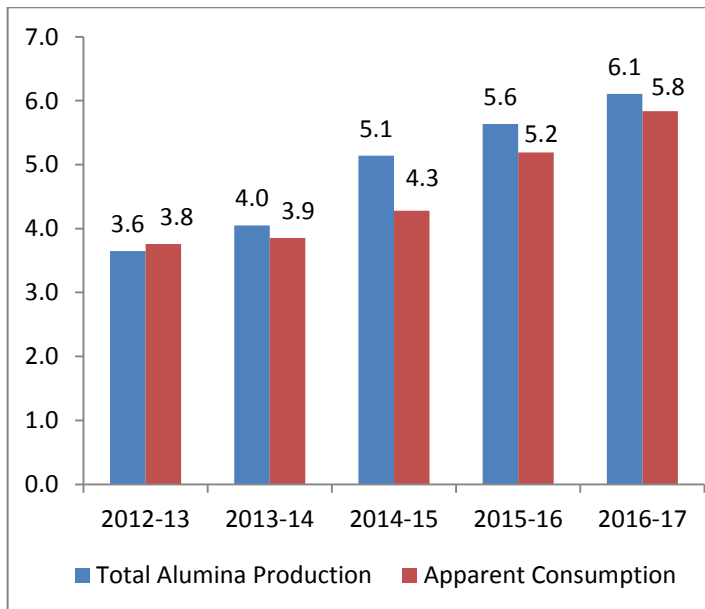
Chart 7: World Alumina Refinery Production for CY 2016



Source: USGS

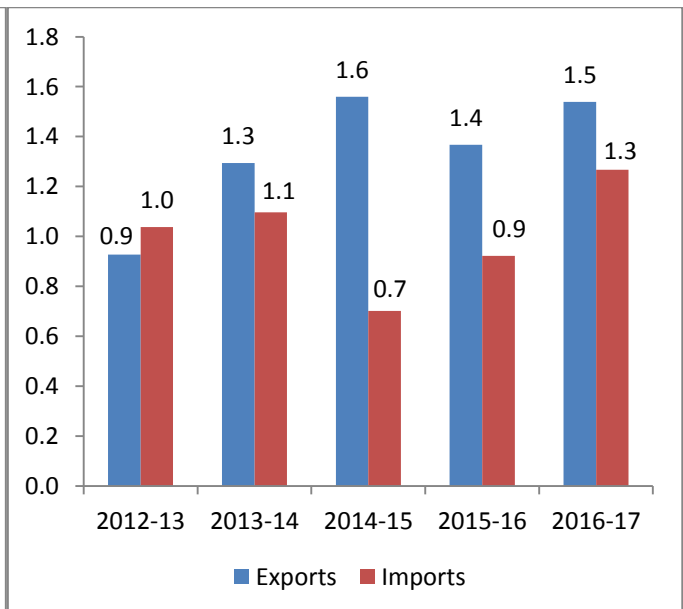
According to the recent USGS report, India ranks 4<sup>th</sup> in terms of production of Alumina and India also produce 5% of the world alumina. China leads in terms of alumina production. Domestic Alumina plants are owned by the dominant three players of the aluminium industry of the country.

Chart 8: Alumina Production- Consumption (mn tonnes)



Source: Company Annual Reports (Hindalco, Vedanta, and NALCO)

Chart 9: Export- Import Trends of Alumina (mn tonnes)



Source: DGFT

Domestic Alumina production is increasing at a growth rate of 13.7% CAGR from FY 2012-13 to FY 2016-17. In terms of production there has been an 8.4% increase y-o-y from FY 2015-16 to FY 2016-17. Most of the alumina produced is used for domestic consumption i.e. by the respective companies which manufacture it, for the manufacturing of aluminium metal.

The surplus alumina is exported. Consumption of alumina on the other hand is growing at a growth rate of 11.6% CAGR FY 2012-13 onwards. There has been a 12.5% y-o-y increase in from FY 2015-16 to FY 2016-17 of alumina consumption. An increase in the consumption of alumina is reflected in the production of aluminium.

India is a net exporter of alumina as most of the companies in the aluminium sector are backward integrated, i.e. 'Backward integration' refers to the ownership of mines to fulfil its ore requirement. Those players who have access to bauxite mines, further process the ore to alumina and export a certain amount of alumina which is left out after captive consumption. Other players, who do not have access to bauxite mines, either import the ore or alumina to feed their refinery/smelters. With a growth in consumption of aluminium there has been a rise in the imports for alumina.

**Table 1: Production Capacity of Alumina Refineries in the Domestic Markets**

Sr No.	Name of the Company	Production Capacity (mn tonnes)
1.	Vedanta	1.7
2.	Hindalco	3.0
3.	Nalco	2.27
	<b>Total</b>	<b>6.97</b>

*Source: Company websites and annual reports*

Refineries are supplied power from the captive power plants. The regional trend of capacities clearly indicates that the new capacities for alumina refining have emerged in the close vicinity of bauxite reserves as against the close proximity of cheap power. Each player is trying to backward integrate himself by focusing on securing its raw material requirements, as the bauxite cost is one of the key elements in determining the cost of production. The acquisition of mines or mining rights has huge gained importance and the companies, who have achieved to do so, have grown stronger and are more able to survive in the down-turns

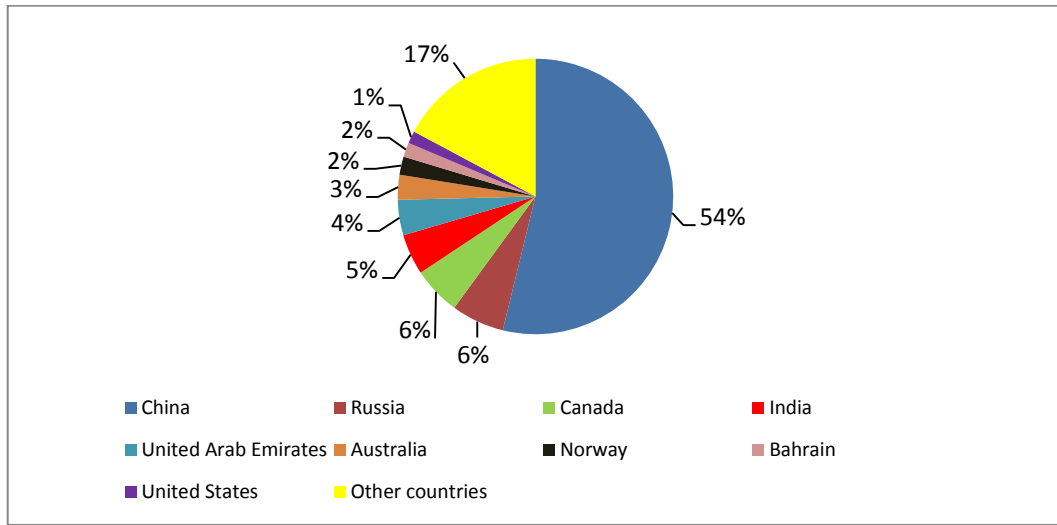
Vedanta Alumina refinery is located at Odisha, Lanjigarh. Hindalco alumina refinery is located in the state of Odisha (Utkal), Jharkhand (Muri), Uttar Pradesh (Renukoot) and Karnataka (Belgaum). NALCO refinery is also located in Odisha (Damanjodi).

## Aluminium

The end product once alumina is passed through the Hall-Heroult process is aluminium. Primary aluminium which is initially in liquid form is casted into extrusion ingots, sheet ingots or foundry alloys, all depending on what it will be used for. Aluminium is three times lighter than iron but it is as strong as steel, extremely flexible and corrosion resistant due to the thin layer of aluminium oxide. Aluminium has been continuously finding new applications due to rising price competence, superior weight to strength ratio, corrosion resistance, formability and dampness.

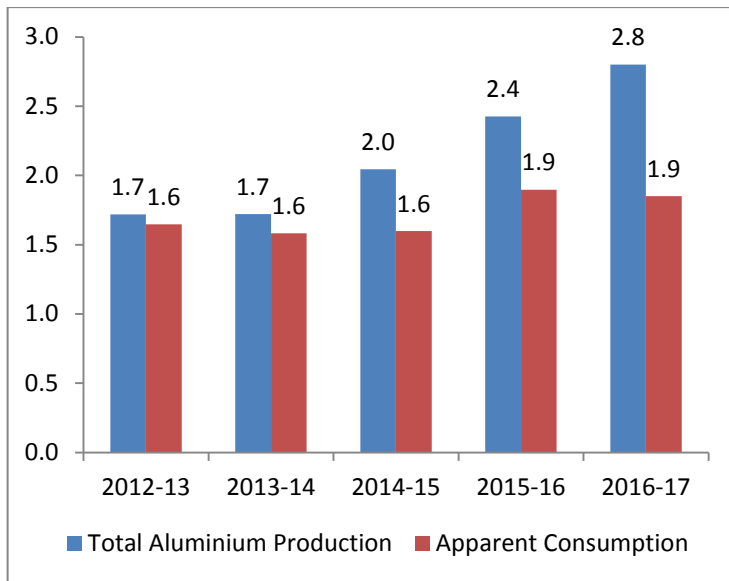
According to the USGS report India ranks 4<sup>th</sup> in terms of primary aluminium production. China continued to be the single largest producer of aluminium, contributing 54% of the total world production. China is also one to the major consumers of aluminium.

**Chart 10: World Primary Aluminium Production for CY2016**



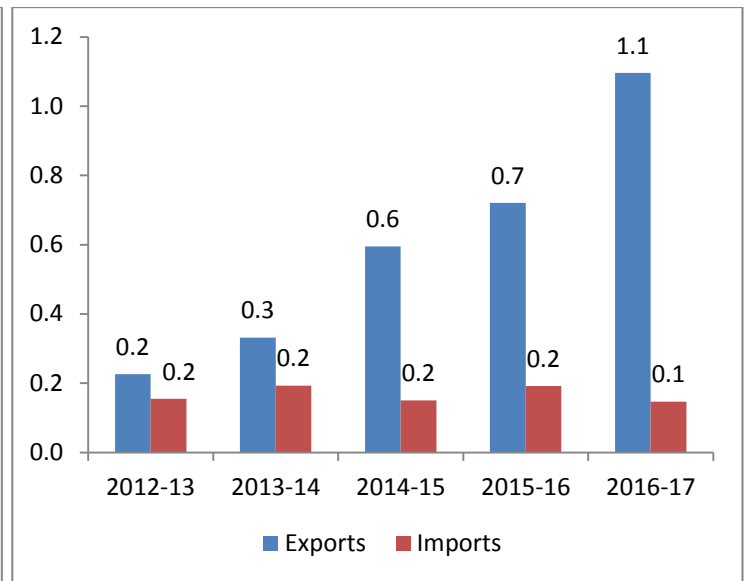
Source: USGS

**Chart 11: Production of Primary Aluminium (mn tonnes)**



Source: Company Annual Report

**Chart 12: Export-Import trend of Ingots (mn tonnes)**



Source: DGFT

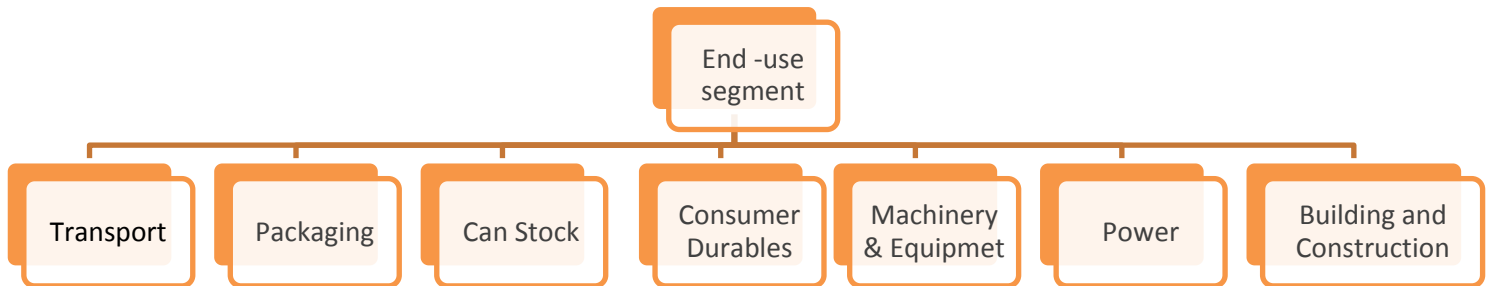
Primary domestic aluminium production is growing at a CAGR of 13% from FY2012-13 onwards. Production of aluminium needs abundant amount of energy. Domestic players rely on coal-fired captive plants for power and fuel requirements. Power accounts for 30% of the total cost of production for aluminium. Indian manufacturers have an advantage of abundant source of bauxite, access to cheap labour and access to captive power plants which aid in increasing the efficiency of the production.

Consumption of Aluminium on the other hand is growing at a CAGR of 3% from FY 2012-13 onwards. Surplus stock is exported mainly to South Korea, Malaysia, Mexico, Italy, Turkey, USA, Taiwan, Spain, Japan, Indonesia, Bangladesh,



Singapore, Brazil and Netherlands. South Korea accounts for around 38% of overall primary aluminium exports of India followed by Malaysia at 14%. Exports of aluminium ingots are growing at a CAGR of 48% from FY2012-13 to FY2016-17. Exports of aluminium ingots have been increasing on a y-o-y basis, 21% from FY 2014-15 to FY 2015-16 and 52% from FY 2015-16 to FY 2016-17.

**Chart 13: End use of Aluminium in the Indian Markets**



Source: CARE Research

On the industrial side, aluminium is mainly used in electrical power transmission, machinery & equipment and construction. For housing as aluminium is a lightweight material it is a good substitute for steel and wood in doors, windows and sliding. On the consumer side aluminium is used in a variety of retail products including cans, packaging, air conditioners, furnitures and vehicles.

**Transport:** Increased financing options, per capita income and lower penetration to drive the demand for automobiles. the hardening of environmental and pollution norms are forcing the Original Equipment manufacturers (OEMS or the automobile manufacturers) to substitute steel by aluminium which helps in reducing the weight of the vehicle. Reduction in weight helps the vehicle to improve upon its mileage thereby reducing the pollution levels emitted from the vehicle. As observed in the past, because of its incomparable properties, use of aluminium is consistently increasing in the production of automobiles.

**Packaging and Can Stock:** With growing consumption, greater demand for packaging materials has emerged especially for aluminium foil and cans in the organized retail segment in the emerging economies. There has been a shift in use of aluminium cans for the consumption of aerated drinks from the use of glass bottles, due to it being light-weight and easy to carry.

**Consumer Durables:** Aluminium is widely used in cooling systems like air conditioners, refrigerators and cooling towers. Rise in disposable income, increasing infrastructural activities and improving power norms are likely to drive the demand for these products.

**Machinery Equipment:** Greater industrialization and investments to spur growth in the aluminium sector due industrial growth in emerging economies.

**Power:** Aluminium, being an excellent conductor of electricity and relatively cheaper priced, is widely replacing copper in its use of power transmission. Given the same weight of the metal aluminium is twice as good in electrical conductivity when compared with copper. Increased focus of the government in the infrastructure sector is likely to attract major investments in the power-generation and transmission sectors

Building and Construction: Aluminium is weather resistant and ensures optimum performance over a longer period of time. Since it is very malleable, it can take a number of forms allowing designers enough flexibility during its usage. This property further allows the metal to be used for a wider range of applications demanding varied surface finishes. Its high strength to weight ratio allows it to be used for windows and curtain wall frames. Aluminium is highly light-reflective and hence aluminium solar collectors can be installed to lower energy consumption for artificial lighting and heating in winters. Aluminium shading devices are also used to reduce the need of air conditioning during summer seasons. Aluminium is also a non-combustible material hence providing additional fire safety properties in its applications.

**Table 2: Production Capacity of Aluminium Smelter in the Domestic Markets**

Sr. No	Name of the Company	Production Capacity (mn tonnes)
1	Vedanta	2.3
2	Hindalco	1.3
3	NALCO	0.46
	<b>Total</b>	<b>4.06</b>

Source: Company websites and annual reports

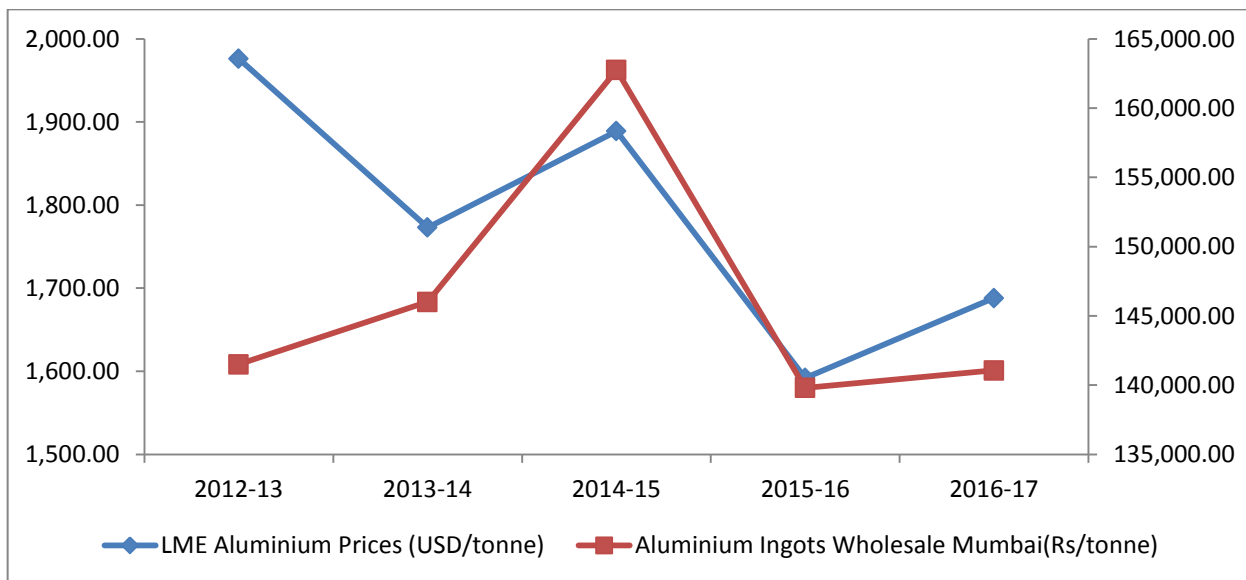
Indian players are constantly increasing their production capacities to cater primarily to the domestic markets and to export the surplus stock to countries deficient of aluminium. Cost of production plays an important role in differentiating companies within the industry. It is the most important primal point, which helps a company strategize to remain competitive with respect to its peers. Cost of production of an aluminium manufacturing company can vary significantly depending upon the availability of its own resources. The more the company is backward integrated, the lesser is the cost of production. Apart from the mining rights, the source of power is also important as it accounts for a significant portion of the aluminium production process.

Vedanta aluminium smelter is located at Odisha (Jharsuguda) and Chhattisgarh (BALCO). Hindalco aluminium smelter is located in the state of Odisha (Aditya Aluminium & Hirakud), Madhya Pradesh (Mahan Aluminium) and Uttar Pradesh (Renukoot). NALCO refinery is also located in Odisha (Angul).

Most of the aluminium smelters are located near their respective alumina refineries. This saves on the cost of transportation and freight.

## International and Domestic Price of Aluminium

Chart 14: International and Domestic Aluminium Prices (USD/tonne and Rs/tonne)



Source: LME and CMIE

Domestic prices of aluminium move in tandem with the landed prices as determined by LME. There is a positive correlation between LME aluminium prices and domestic aluminium prices.

Since China is one of the one of the major consumer and producer of the metal, the economic conditions of the nation, the smelter capacity production projections and any ramp up or shut down of plants have a direct bearing on aluminium prices. LME daily publishes inventory levels of aluminium which has a direct impact on the prices of aluminium and on the stock prices of aluminium producing companies.

Global aluminium prices had taken fallen sharply in FY 2015-16 (USD 1592/tonne) falling 16% y-o-y from the prices in FY 2014-15(USD 1889/tonne). Prices of aluminium have shown some recovery in FY 2016-17. In FY 2016-17 global aluminium prices recovered by 6% (USD 1688/tonne).

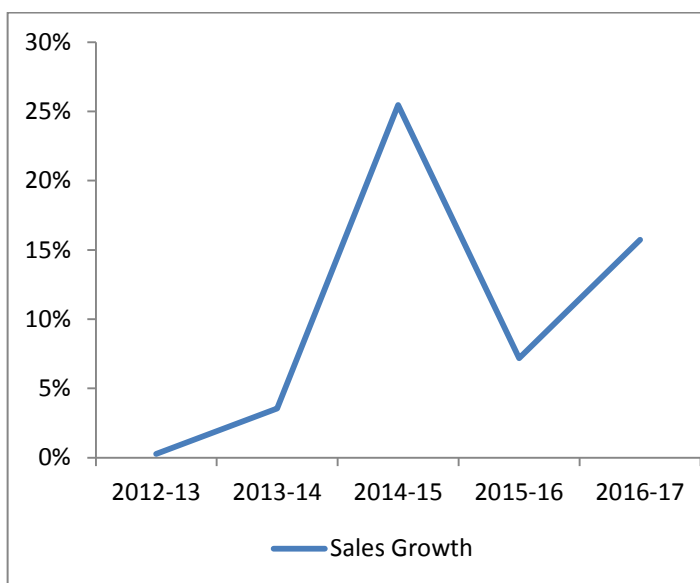
The Chinese economy experienced a slowdown due to the change from an investment driven economy to a consumer driven economy during the years 2013 to 2015. Oversupply of Chinese aluminium due to overcapacity had caused the prices to fall sharply in FY 2015-16, Q3FY16 the prices of aluminium globally was the lowest (USD 1494/tonne). The LME prices continued to remain depressed till the end of 2015.

FY2016-17 there was a pickup in Chinese demand due to stimulus measures, adopted by the Chinese economy. Post the U.S elections, LME prices in aluminium witnessed a rally due to expected boost on infrastructure development by the new President.

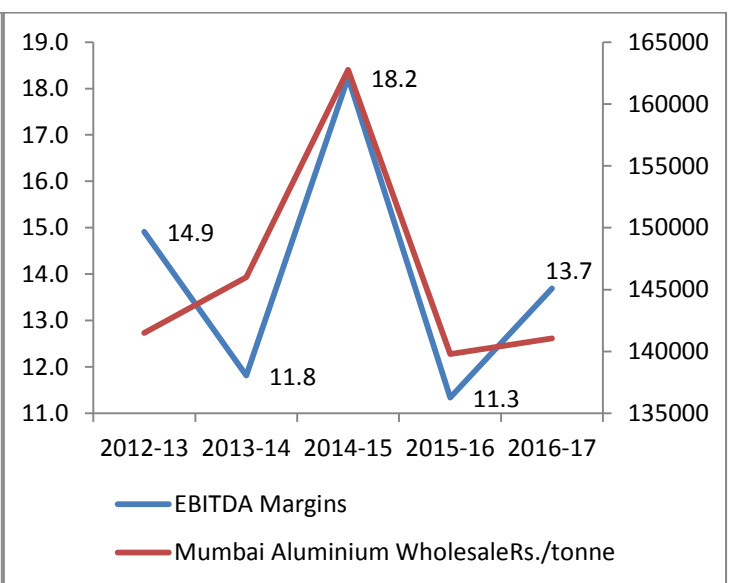
### Financials of the Aluminium Industry

To understand the financial performance of the aluminium industry we have analysed the sales growth and operating margins of the three major players which dominate the Indian Aluminium market. We have considered the segmented sales and operating profits of Vedanta and Hindalco Aluminium division and the standalone financial statements for National Aluminium Company.

**Chart 15: Sales Growth Rate**



**Chart 16: Operating Profit Margins (in %)**



Source: BSE India

The sales realisation and operating profit margins of the domestic aluminium players largely depends on the aluminium prices globally and in the domestic markets. Global commodity prices were extremely volatile during the FY 2014-15 onwards due to the slowdown in the Chinese economy which in turn affected the domestic prices for aluminium which had a direct bearing on the sales growth and operating profit margins of the domestic aluminium players. Higher price of metal in FY 2014-15 has led to a higher growth in sales and increased operating profit margins.

In FY 2015-16, the aluminium industry witnessed significant challenges as the average realisations declined. The price of aluminium globally was 16% lower than the previous year. FY 2016-17 a recovery in the prices of aluminium has also reflected in an improved operating profit margin and sales growth.

## Conclusion/Outlook

India is amongst the lowest cost producers of aluminium across the world, owing to easy availability of raw materials and comparatively labour costs. The growing demand for aluminium in the last decade, driven by India's underlying growth story has resulted into expansion of smelting capacities of the major domestic players. With the addition of new aluminium capacities India aims at not only satisfying the domestic demand, but also play a major role in the global aluminium market.

- Production is expected to grow to cater to the domestic demand rise due to various initiatives taken up by the government and the surplus stock will continue to be exported.

**Table 3: Production trend of Bauxite, Alumina and Aluminium (mn tonnes)**

	FY 2016-17	FY 2017-18 (E)	FY 2018-19 (E)	FY 2019-2020 (E)
Bauxite	24.80	26.29	28.13	30.38
Alumina	6.10	6.47	6.92	7.47
Aluminium	2.80	2.94	3.12	3.33

Source: CARE Ratings Industry Research

With the ramping up of the smelter capacities, India is likely to increase its aluminium production in line with increasing domestic demand. The industry is also likely to be in apposition to export the surplus production, owing to its low cost advantage.

- Consumption of Aluminium is picking up pace. Reforms proposed by the Government of India like the Make in India Campaign, Smart Cities, Rural Electrification and a focus on building renewable energy projects under the National Electricity Policy can drive up the consumption of the metal.

**Table 4: Consumption trend of Bauxite, Alumina and Aluminium (mn tonnes)**

	FY 2016-17	FY 2017-18 (E)	FY 2018-19 (E)	FY 2019-2020 (E)
Bauxite	24.50	25.97	27.79	30.01
Alumina	5.80	6.09	6.46	6.91
Aluminium	1.90	1.96	2.03	2.11

Source: CARE Ratings Industry Research

Care Ratings expects consumption of aluminium is likely to grow at a CAGR of 3.5% during the next 2-3 years. The growth in consumption is likely to be driven by the growth in power transmission and the automobile sector. Demand from the

building& construction and consumer durable segment is likely to remain subdued. However demand from the packaging sector is likely to support the domestic demand.

Consumption of Bauxite and Alumina are likely to move in tandem with the domestic aluminium production trend. However CARE Ratings further surplus production of alumina will lead to increasing alumina export

- *Prices of Aluminium have shown recovery over the past financial year. One of the main reasons for the recovery in the prices of the metal is due to measures taken up by the Chinese Economy and due to the renewed sentiments towards the demand for aluminium.*

*Shutdown of illegal and polluting smelters, which will result in a cut in capacity, has resulted in this surge. Also producers of China are upgrading their production facilities.*

*New Smelting capacity growth in China is expected to slow down significantly due to supply side restrictions.*

Aluminium prices will experience an upward trajectory due to pick up in demand from the European markets as well.

***CARE Ratings estimates the prices of LME aluminium to hover around USD 1800/tonne- USD2000/tonne in the short to medium term period.***

- *Due to the surge in LME aluminium prices from FY2016-17 onwardst he aluminium industry producers are expected to have better realizations, which is a boon due to the recent rise in costs of production.*

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